The Journal of Laryngology and Otology
April 1994, Vol. **108**, pp. 294–298

Relevant demographic factors and hearing impairment in Saudi children: epidemiological study

SAMEER ALI BAFAQEEH, M.D., SIRAJ M. ZAKZOUK, F.R.C.S., HAMAD AL MUHAIMEID, M.D., ABDULRAHMAN ESSA, M.D.

Abstract

A representative sample of 6421 Saudi children were clinically examined and screened for hearing loss. Hearing impairment was detected in 494 children (7.7 per cent). In 326 of the children it was due to chronic secretory and suppurative otitis media (5.07 per cent) and in 168 of them sensorineural hearing loss (2.6 per cent).

The study revealed that parental education, low income, and employment of the mother showed a slightly higher at risk rate of hearing impairment. Children from related parents were also at a higher risk of hearing impairment and they demonstrated a marked adverse effect on the incidence of hereditary sensorineural hearing impairment. Comparison with other surveys of school children in developed and developing countries has been carried out.

Key words: Hearing loss, sensorineural; Otitis media with effusion; Otitis media; Socioeconomic factors; Demography; Developing Countries

Introduction

The sense of hearing is of vital importance. Unfortunately, the nature of the hearing loss makes diagnosis difficult. Delay in detection of significant hearing impairment will lead to loss of development of skills in speech, language and social interaction.

In this paper, results of a large scale epidemiological study on hearing impairment in Riyadh, Saudi Arabia is presented to assess the effect of relevant demographic factors on hearing impairment among Saudi infants and children and to reveal the true dimension of this problem. A comparison with other surveys of school children in developed and developing countries was carried out.

Material and methods

A random sample survey of 6421 Saudi infants and children below the age of 12 years was carried out in Riyadh, Saudi Arabia, for a 27-month period from May 1988 to September 1990. The sampling was designed to give an adequate and representative covering of all socioeconomic and demographic groups of the Saudi population living in Riyadh. The sampling design was essentially a three-stage, stratified, random sampling using age and sex as stratifying factors in the final stage. The city was divided into 93 administrative areas and these areas were distributed into six strata according to socioeconomic homogeneity. One-fifth of the areas in each stratum were chosen by simple random methods. Each area was further subdivided into roads and the later were subsequently divided into smaller blocks of approximately equal size; a sample from each block was randomly selected. Within each block selected a systematic process was carried out whereby, a random starting point was chosen and a predetermined zigzag route followed calling at every other household encountered. Each child was assigned a code number and the questionnaires were subsequently designated by code numbers only. Each child attendant was asked to answer a questionnaire which included among many other variables, the age, sex, the parental relationship, family history of deafness, any complaint of hearing or speech defect, and history of exposure to the known causative factors of childhood deafness. All children with a suspected history of hearing loss or exposure to the known factors were physically examined and then subjected to pure tone audiometry or to auditory brain stem evoked response depending upon their mental age and cooperation. A sample of the negative questionnaire respondents were also audiologically tested. Serological tests for antibodies against syphilis, toxoplasmosis, cytomegalic virus, rubella and herpes simplex were carried out for the 1072 children who were able to attend for laboratory investigation. The results of these tests are of value in demonstrating the causes of some cases of hearing impairment. A child is considered to have hereditary hearing problems if there is a positive family history. A sibship was considered as having a positive family history if a parental sib was deaf without the deafness being caused by environmental factors, regardless of the parental hearing

From the Department of Otorhinolaryngology, King Abdul Aziz University Hospital, Saudi Arabia.
Accepted for publication: 29 December 1993.

status. Deafness in children with positive environmental factors, (prematurity, meningitis, rubella, mumps, etc.) was considered to be due to these factors. Deafness in children with neither family history nor environmental history was considered to be of unknown cause. If both family and environmental histories are present, the children are placed in either category depending upon the clinical judgement of the otologist supported by the relevant laboratory results.

Results

The study sample consisted of a total of 6421 Saudi children; 55 per cent were boys and 45 per cent were girls. The age distribution of these children is shown in Table I. The number of children considered to be at risk from hearing impairment was 1256 according to the following criteria:

(1) Family history of childhood hearing impairment (hereditary).
(2) Perinatal infectiona (e.g. rubella, syphilis, cytomegalovirus, herpes simplex).
(3) Anatomical malformation of the ear, head and neck.
(4) Birth weight less than 2500 g associated with neonatal asphyxia.
(5) Hyperbilirubinaemia at levels exceeding the indication for exchange transfusion.
(6) Bacterial meningitis.

Auditory brain stem evoked response was performed on 879 and pure tone audiometry on 377 children. The number of infants and children with hearing impairment was 494: sensorineural hearing impairment was found in 168 (2.6 per cent; SE = 0.002); 295 (5.2 per cent) children had conductive hearing loss; and 31 children had mixed hearing loss. Types of hearing loss are summarized in Figure 1. Distribution of the other contributing factors of hearing impairment are shown in Figure 2. Hereditary factors were thought to be the cause of 111 cases of sensorineural deafness. In other words the prevalence of hereditary hearing loss was 1.7 per cent (SE = 0.0016) amongst the population studied. The demographic characteristics are as follows:

Sex and age

The study sample was divided into two groups 'hearing impaired' and 'normal'. The sex of the children, in the sample indicated that slightly more boys than girls were diagnosed as having hearing impairment. About 8.6 per cent of boys were classified in to the 'hearing impaired' group as compared to 6.5 per cent of girls. Age of the children, indicated that relatively higher rates of hearing impairment were found in children between the ages of two and seven years (Table I).

TABLE I
THE AGE DISTRIBUTION OF THE 6421 CHILDREN WHO ENTERED THE STUDY

Age	Number of children	Percentage
12 months	1004	15.6
13–24 months	851	13.2
25–36 months	683	10.6
37–48 months	676	10.5
49–60 months	638	9.9
61–72 months	651	10.1
73–84 months	374	5.8
85–96 months	347	5.4
97–144 months	1178	18.3
No data	19	0.3
Total	6421	100.0

Parental education

The reported education level of the mothers and fathers of the study sample children were similar to the national pattern. Overall, as shown in Table II, more than one-fifth of the mothers (21.3 per cent) had completed either secondary or college education, while 14.7 per cent had completed elementary school. As shown in Table III, 45.5 per cent of the fathers had completed either secondary or college education, and 23.3 per cent had completed elementary school. Those who were classified as 'illiterate' or could only 'read and write' accounted for 22.6 per cent. In terms of the demographic background of the children in the sample and the relationship to the risk of hearing impairment, the results showed that the educational level of the children's mother and fathers had no statistical association with risk rates.

Family income level

Nearly half (48.2 per cent) of the sampled Saudi children belonged to middle income families with an average between SR 5000 and SR 9999 per month (US $1333–US $2666). The high income group (with an average monthly income exceeding SR 10 000 (US $2667) accounted for 18 per cent of the sample, while 23.5 per cent of them belonged to the low income group (less than US $1333). Overall, about 10.3 per cent of the sample did not give any information about the family income. Those children who had a lower socioeconomic family background tended to have a higher risk of hearing impairment than the middle and upper class children (Table IV).

Parental occupations

The children of mothers who were employed, either full-time or part-time, had a higher risk rate than those whose mothers were housewives – the respective risk rates

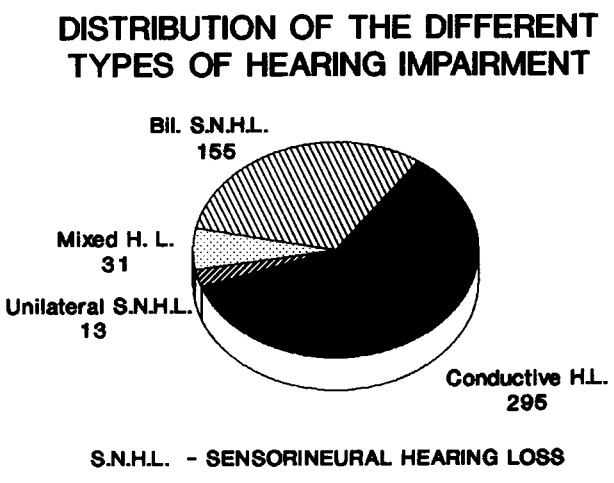

FIG 1

https://doi.org/10.1017/S0022215100126581 Published online by Cambridge University Press

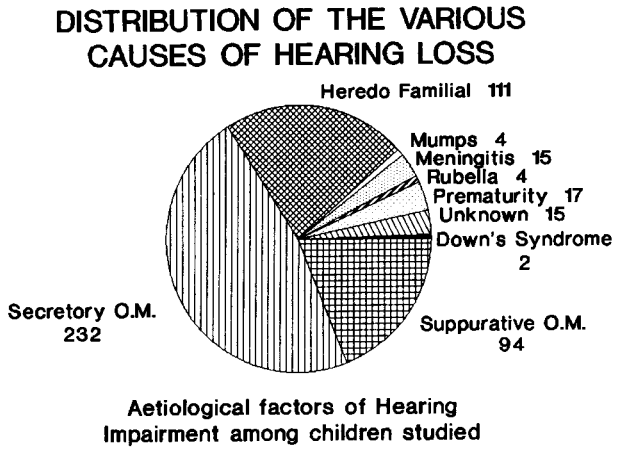

FIG 2

were 7.1 per cent and 5.8 per cent (Figure 3). About 39 per cent of the fathers were either in professional or managerial positions or had their own businesses. Those engaged in clerical work accounted for 18.9 per cent, while 30 per cent were in blue collar jobs (Figure 4).

Consanguinity of parents

Consanguinity was found to be an important factor in relationship to the children's risk of hearing impairment. Clinical examination of the present group of sampled children indicated that those with parents married to their first cousins were at higher risk than those with parents married to nonrelatives or other relatives. The relationships of the parents were as follows: 1419 (22.1 per cent) were first cousins; 1477 (23 per cent) were second cousins; 3088 (48.1 per cent) were not relatives while 437 (6.8 per cent) gave no definite answers. Parental relationships more distant than second cousins were labelled as nonrelatives (Table V).

Discussion

Prevalence of hearing impairment in the Qasim region (Saudi Arabia) was found to be as high as 30 per cent amongst school children (Zakzouk and Sengupta, 1982) and the present study shows that a significant proportion of children in Riyadh (7.7 per cent) had hearing impairment. For these cases, the aetiology appeared to be due not only to bacterial middle ear infection but also to other major factors such as hereditary and consanguinity. The importance of accurate identification of the cause of congenital deafness is fundamental to the understanding of the possible prevention of this condition. The traditional methods used in clinical practice of history taking and clinical examination may help to identify the likely cause in children whose deafness is part of a well-recognized syndrome which is known to have a genetic basis and where the history and examination indicate the likelihood of a significant incident occurring during the perinatal period. The clinician is at greater loss for an explanation of the likely cause of deafness where the child under examination has no significant history of any ante- or perinatal problem nor evidence of any of the known features of the described syndromes, nor any family history of genetic deafness. The size of this problem of identification of the cause of deafness is indicated by the figures given in large series where a very significant number of congenitally deaf children are placed into a category where the cause of deafness cannot be identified. Results showed that consanguinity is widely practiced in our community: first cousin marriage was present in 22.1 per cent of the parents of the children and more distant consanguinity (second cousins) was present in 23 per cent. The prevalence of consanguineous mating was found to be dictated, to a large extent, by culture, traditions, religion and civil law. It is extremely common in some parts of the World like South India (Gray, 1984) due to traditions; it is not common in other parts of the World like North America, because the low birth rate reduces the number of relatives available and also because some consanguineous marriages are prohibited by law or religion. The other significant result to emerge from this study is the high absolute prevalence of hereditary hearing impairment (1.7 per cent) in comparison with less than a 0.6 per cent incidence reported by many authors (Taylor *et al.*, 1975; Smith, 1986). This high prevalence may be explained, in part at least by the widespread practice of consanguinity. The effect is also proportional to the closeness of the relationship of the parents concerned (Stevenson and Cheeseman, 1956). Prevention is the only means of reducing the incidence of genetic hearing loss, and this prevention can be accomplished by genetic counselling of individuals and families with risk factors. Adequate understanding by the general public and medical profession is necessary.

Children who had lower socioeconomic family conditions tended to have a higher rate of hearing impairment than the middle and upper class children. Also those children whose family income was below SR 5000 (US $1333) per month had relatively higher rates than other children. A three-year survey by Obiako (1987) at the University of Nigeria teaching hospital was carried out to determine the causes of deafness in children. Measles, seizures and meningitis, were identified most frequently as factors causing this handicap. Due to poor medical facilities and widespread malnutrition, communicable diseases in children produce high rates of morbidity and mortality. As a result, a high percentage of infants acquire

TABLE II
EDUCATIONAL CHARACTERISTICS OF THE MOTHERS

Mother's education	Number of mothers	Percentage
Illiterate	2523	39.3
Read and write	1085	16.9
Completed elementary	944	14.7
Completed secondary	989	15.4
College studies	379	5.9
No answer	501	7.8
Total	6421	100.0

TABLE III
EDUCATIONAL CHARACTERISTICS OF THE FATHERS

Father's education	Number of fathers	Percentage
Illiterate	456	7.1
Read and write	995	15.5
Completed elementary	1490	23.2
Completed secondary	1502	23.4
College studies	1419	22.1
No answer	559	8.7
Total	6421	100.0

https://doi.org/10.1017/S0022215100126581 Published online by Cambridge University Press

TABLE IV
FAMILY INCOME LEVEL

Monthly family income		Number of families	Percentage
SR	US dollars ($)		
Less than SR 5000	Less than US $1333	1509	23.5
SR 5000–7499	US $1333–2000	1991	31.0
SR 7500–9999	US $2000–2666	1104	17.2
SR 10 000–14 999	US $2667–4000	861	13.4
SR 15 000 and above	US $4000 and above	295	4.6
No answer		661	10.3
Total		6421	100.0

disabilities, including profound deafness. Improvement of health care, delivery system, breast feeding, and compulsory immunization of all babies against infectious diseases, as well as making specialist centres accessible to all, are suggested as the most efficacious ways in which to arrest the high incidence of profound deafness in childhood in developing countries. Few surveys have been made of deaf children in developing countries. Eight hundred Nigerian deaf children were studied by Holborrow *et al.* (1982). Of the cases of deafness 3.2 per cent were thought to be of familial origin, and 1.5 per cent due to rubella. An incidence of 18 per cent was noted following meningitis and 19 per cent following measles. A study by McPherson and Holborrow (1985) in Gambia established a figure of 2.7 cases of severe sensorineural deafness per 1000 live births and noted a high incidence of meningitis but a low incidence of rubella deafness. This compares unfavourably with the usually accepted figure of 1:1000 in developed countries. A study of 100 Ghanaian children by Brobby (1988) found no deafness which could be considered to be genetic, 22 per cent of unknown cause and four per cent caused by rubella. In developing countries limited access to health care means that reliance has to be placed on a memory of symptoms rather than on case records so that reliable percentages are hard to establish.

One-third of the hearing impaired children (168 children: 34 per cent) had sensorineural hearing loss. Almost one-half (232 children: 47 per cent) has been proved to have secretory otitis media. Ninety-four (19 per cent) children were found to have chronic suppurative otitis media, which in a sequelae of untreated, or inadequately treated, acute otitis media. More than half of these children (57 per cent) belonged to the middle or low socioeconomic class ($p \geqslant 0.05$). The prevalence rate of chronic suppurative otitis media in native North Americans has dropped significantly from 13 per cent in 1965 to 0.9 per cent in 1985 (Fischler *et al.*, 1985), which reflects improvement of health status and proper medical services provided for them. Socioeconomic status of the population plays a role in the incidence of chronic secretory otitis media in children. Therefore, it is clear that chronic ear disease is not uncommon in areas where health services are not sufficiently provided and with low socioeconomic conditions, then the prevalence is high. Many factors contribute to susceptibility to chronic ear disease in addition to environmental factors and repeated attacks of acute otitis media. Awareness of the sequelae of ear disease among physicians, and early proper management of acute otitis media, may prevent its progression. Sensorineural hearing loss has been well documented as occurring with clinically evident otitis media. The mechanism suggested for sensorineural impairment in these patients has been the passage of inflammatory agents or toxins from the middle to the inner ear, the round window membrane, being the most likely site of entry (Paparella *et al.*, 1989). Numerous studies have shown the round window membrane to be permeable to various toxins (Schachern *et al.*, 1981) and to antibiotics (Harada *et al.*, 1986). In Greenland, Pedersen and Zachan-Christiansen (1986) in 1985 to 1986 examined 142 children aged 3.8 years and found chronic otitis media in six per cent and sequelae of chronic otitis media in 13 per cent. Comparison of children with healthy ears with groups with affections of the middle ear showed a tendency to an increased risk of otitis media in families of a low social stratum, where the mode of habitation seemed significant. The education level of the parents had no statistical association with the risk rate. Ashoor (1983) in a study of school children in the Eastern province of Saudi Arabia found that the hearing impairment problem is more frequent in middle class families with a relatively large family size, low parental education and poor standard of hygiene. This may be due to the fact that information related to parental education was given by the school children and thus may be inaccurate. On the other hand in this study, children of mothers who were employed either full or part-time, had higher percentage rates (7.1 per cent) than those whose mothers were housewives (5.8 per cent). However, application of the *t*-test did not show any significance which signifies that the percent-

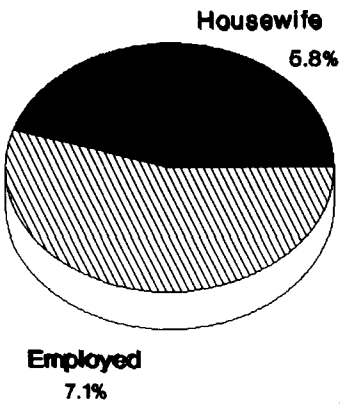

FIG 3

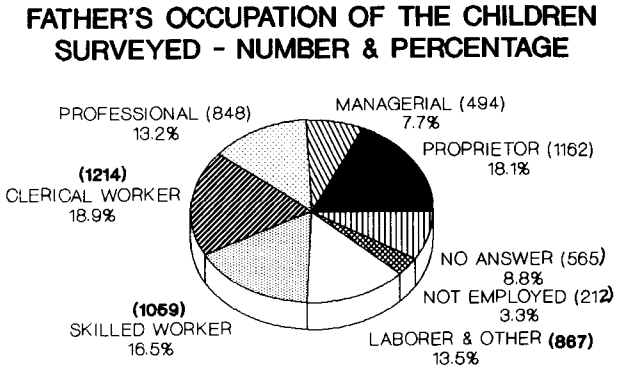

FIG 4

https://doi.org/10.1017/S0022215100126581 Published online by Cambridge University Press

TABLE V
DISTRIBUTION OF HEREDITARY SENSORINEURAL HEARING IMPAIRMENT CORRESPONDING TO PARENTAL RELATIONSHIPS

Parental relationships	Number of children (%)	Number with hereditary deafness	Incidence/population (95% confidence limit)
Parents first cousins	1419 (22.1)	39	2.75 (1.9 –3.6)
Parents second cousins	1477 (23.0)	23	1.56 (0.93–2.19)
Parents nonrelatives	3088 (48.1)	43	1.39 (0.98–1.8)
Parents undetermined relationships	437 (6.8)	6	1.37 (0.28–2.46)
Total	6421	111	1.73 (1.41–2.05)

age differences are due to a change in variables ($p > 0.05$). The observed percentage differences can be substantiated by the fact that the working mother usually depends on inexperienced, ignorant servants, or relatives to take care of the children during their absence at work. These substitutes may not give the optimum care needed. Disorders or health problems of the children may not be recognized early, some of which may be predisposing factors for hearing impairment.

Moreover, it can be postulated that a segment of the working mothers are of low socioeconomic standard and this may increase the risk of hearing impairment.

Conclusion

This study showed that consanguinity is widely practiced in Saudi communities due to social customs. The practice of arranged marriages within families and the unawareness of the public about the adverse genetic effect of such practice was also shown. In this study factors such as poor parental education, low income families and employment of the mother showed a higher risk for hearing impairment.

Acknowledgements

We would like to thank King Abdul Aziz City of Science and Technology (KACST) for financial support of the project: Dr Fawziah Al-Kandari, Medical Labor, for her valuable advice throughout: all the doctors, nurses, laboratory technicians, social workers and support staff in King Abdul Aziz University Hospital. Special thanks must be given to all the parents and children who gave us all the assistance we needed to make the necessary measurements.

References

Ashoor, A. (1983) Hearing levels of school children in Dammam. *Journal of Laryngology and Otology* **97:** 37–41.

Brobby, G. W. (1988) Causes of congenital and acquired total sensorineural hearing loss in Ghanaian children. *Tropical Doctor* **18:** 30–32.

Fischler, R. S., Todd, N. W., Feldman, C. M. (1985) Otitis media and language performance in a cohort of Apache Indian children. *American Journal of Diseases of Children* **139:** 1355–1360.

Gray, R. F. (1984) Causes of deafness in Schools for the Deaf in Madras. *International Journal of Pediatric Otorhinolaryngology* **18:** 97–106.

Harada, T., Jwamor, M., Nagai, Y. (1986) Ototoxicity of neomycin and its penetration through the round window membrane into perilymph. *Annals of Otology, Rhinology and Laryngology* **95:** 404–408.

Holborow, C., Martinson, F., Anger, N. (1982) A study of deafness in West Africa. **4:** 107–132.

McPherson, B., Holborow, C. A. (1985) A study of deafness in West Africa: the Gambian Hearing Health Project. *International Journal of Paediatric Otorhinolaryngology* **10:** 115–135.

Obiako, M. N. (1987) Profound childhood deafness in Nigeria: a three-year survey. *Ear Hear* **8:** 74–77.

Paparella, M. D., Rick, Y., Fox, M. D., Schachern, P. A. (1989) Diagnosis and treatment of sensorineural hearing loss in children. *Otolaryngologic Clinics of North America* **22:** 52–74.

Pedersen, O. B., Zachan-Christiansen, B. (1986) Otitis media in Greenland children. *Journal of Otolaryngology* **15:** 332–335.

Schachern, P. A., Paparella, M. M. Gycoolea, M. V. (1981) Round window membrane following application of staphylococcal exotoxin: an electron microscopic study. *Laryngoscope* **91:** 2007–2016.

Smith, R. J. H. (1986) Medical diagnosis and treatment of hearing loss in children. In *Otolaryngology – Head and Neck Surgery:* Vol. 4. (Cummings, C. W., ed.), C. V. Mosby Co., St. Louis, pp. 3225–3246.

Stevenson, A. C., Cheeseman, E. A. (1956) Hereditary deafmutism, with particular reference to Northern Ireland. *Annals of Human Genetics* **20:** 177–231.

Morris, T. (1975) A study of the causes of hearing loss in a population of deaf children with special reference to genetic factors. *Journal of Laryngology and Otology* **89:** 899–914.

Zakzouk, S. M., Sengupta, D. K. (1982) Ear, nose, throat health status of school children. *Saudi Medical Journal* **Monograph No. 1 (special issue):** 28–31.

Address for correspondence:
Dr Sameer Ali Bafaqeeh,
Department of ORL,
King Abdul Aziz University Hospital,
PO Box 245,
Riyadh 11411,
Saudi Arabia.